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Forest and Erosion Concepts

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MUCH has been said within the past few years about soil and water conservation and especially about the relations between forestry and the conservation of these resources. For this reason it may now not be out of place to review some of the fundamental conceptions regarding soil erosion and the relation of forestry to this process.

To better understand how forests are involved in the conservation of soil it will be of value to briefly describe the forces which act, either to hold the soil particles together, or to cause them to separate and be moved from their original resting place.

The forces which tend to bind the soil particles together are found chiefly within the soil itself. Soil is made up of a multitude of small weathered rock and mineral particles interspersed with organic matter. The inorganic particles in the soil are designated according to size, the largest being termed small gravel; the intermediate ones, sands and silts; and the finest, clays. Each soil particle is surrounded by a water film of variable thickness, and within this water film are found mineral elements and gasses in solution. The binding force within the soil is generally considered to be this water film. The thinner the film and the smaller the particle it surrounds, the greater is the force that is exerted toward holding the soil particles together. For this reason soils having high percentages of clay or organic matter, either of colloidal or non-colloidal nature, resist erosion more than do soils with larger percentages of sands and silts.

BEFORE a soil erodes, either there must be enough force to cause large aggregates of soil particles to move, or the water film around the individual particles in the aggregates must increase in thickness until free water appears and the cohesive force between adjacent particles is lost. When water is applied to a clay soil, a long time elapses before the soil becomes saturated to the point where free water appears and cohesion is lost. This is due to the large volume of water which a clayey soil will hold and also to the fact that the particles are so close together and the water film is so thin and extensive that saturation is slow in being accomplished. Sandy and silty soils generally erode much faster than clays. Under conditions of moderate run-off silts will probably erode faster

Unchecked erosion.

than sands because silts have very little of the cohesive properties of clays and do not have the mass of the individual sand particles. When exposed to the action of large volumes of rapidly moving water both sands and silts erode readily.

Other forces which are a part of the binding force in the soil result from the chemical and physical properties of the soil colloids and from the mineral bases which are absorbed on these colloids.

Opposed to the forces binding soil particles together is another group of forces tending to cause individual soil particles to separate and move away from their original resting place. These forces arise from either wind or water. Only water will be considered here.

WATER as an eroding force acts in a number of ways. First, as has been shown, water seeps into the soil, enlarges water films, reduces cohesion between soil particles, and causes individual particles to "float" separately. Secondly, free water moving over the surface of the soil causes the loosened soil particles to be carried away, either in suspension, by rolling or sliding, or by a process known as saltation. Lastly, the beating effect of precipitated water aids in breaking up soil aggregates and loosening individual soil particles.

The capacity of free water to cause erosion as it moves over the soil surface varies. The size of the particle which running water can move is generally considered to vary as the sixth power of the water velocity. The actual soil carrying power in terms of quantity varies, however, as approximately the fourth power of the velocity; that is, doubling the water velocity increases the carrying capacity sixteen times. The velocity of the water which causes erosion increases or decreases depending upon the steepness of the slope over which is moves and upon the volume of water flowing. Increasing either the steepness of the slope, or the volume of water, or both, increases the water velocity and hence its eroding power.

VEGETATION can reduce erosion either by increasing the cohesion forces within the soil, as illustrated by increasing the organic content, or by decreasing the forces causing the separation of particles. Generally vegetation acts to a greater degree in the latter manner. The magnitude of these soil dispering forces is closely related to the manner in which water and precipitation is disposed of. As stated by Forsling, formerly director of the Intermountain Forest and Range Experiment station, rain and snowfall on vegetated areas is disposed of as follows:

1. Part of it is intercepted by vegetation and litter and is evaporated.
2. Part of it enters the soil.
3. Part of it goes off as run-toff; this being the part that causes erosion.

VEGETATION generally directly affects erosion by reducing the amount of run-off and by lessening and distributing the direct forces of falling rain and running water. This is accomplished in the following ways.

1. Vegetation causes raindrops to lose their impact before reaching the soil. The vegetation shatters the rain, and distributes it in the form of a mist, thus keeping aggregate soil particles from being split up.
2. Vegetation intercepts part of the rain, delaying its passage to the ground and allowing part of it to be evaporated. This action reduces run-off and delays saturation of the soil.
3. Vegetation absorbs and transpires large quantities of water thus reducing soil moisture content and enabling soil, during periods of rainfall, to absorb a greater quantity of water.
4. Vegetation, through dead plant bodies, increases the humus content of the soil and as a result increases porosity, soil water percolation rates, and absorptive capacity.
5. Vegetative bodies often act as small check dams across the path of water flow and result in the development of small hydrostatic heads of water. These reduce the velocity of the water close to the surface of the soil and assist absorption and percolation by increasing the effective time the water is on the ground.
6. Vegetative bodies lying on the ground act as a roof between soil and rain, the frictional forces of the run-off being expended against the vegetational debris and not the soil particles.
7. Litter and duff left by vegetation filter out soil particles that might otherwise settle into the soil and clog up the percolation channels thus reducing absorption and increasing run-off.
8. The root systems of vegetation act as soil binders.

THE efficiency of vegetation in controlling run-off and erosion depends upon the height, volume, and density of the canopy, upon the nature and extensiveness of the root system, and upon the type of soil mantle which that particular type of vegetation affords the soils. Forests, on areas where they normally are the climax vegetation, are generally the most effective in controlling erosion because (1) they have the largest volume of canopy; (2) they have layers of secondary vegetation close to the soil and consisting of herbs and shrubs; (3) they have a layer of litter and duff which further protects the soil, prevents early freezing and allows greater percolation;

and (4) they generally have soils of looser construction, greater pore space, and deeper percolation channels.

In areas where grass is the climax vegetation this type of vegetation will probably be the most satisfactory to use for erosion control, while on transitional areas combinations of forest trees and grass will no doubt be most effective.

In general it is believed that grass is effective in erosion control by virtue of the greater mass of fibrous roots in the immediate surface soil, the absorptive nature of the soil if the area is not grazed, and the action of the dead and living grass blades which restrict the surface water flow and act as a buffer between soil and run-off water. Conversely, forests are efficient because the rainfall is slower in reaching the ground and it is prevented from having direct contact with the soil by the litter and duff. In addition most true forest soils will absorb more water, and at a more rapid rate, than soils supporting other vegetation. Hence, forests conserve soil by reducing the amount of run-off. This is accomplished chiefly by increasing the amount of water absorbed. Forests thus conserve soil by conserving water.